REMARKS

Claims 1-13 are pending in the application. Applicant amends claims 1 and 5 and cancels claims 2 and 7-13 herein. The Examiner is respectfully requested to reconsider and withdraw the rejections in view of the amendments and remarks contained herein.

REJECTION UNDER 35 U.S.C. § 103

Claims 1-6 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Motoshi (JP 10-044399) in view of Takeshi et al. (JP 2000-334965). This rejection is respectfully traversed. Notwithstanding and solely in the interest of clarification, Applicant amends claims 1 and 5, and cancels claim 2.

Amended claim 1 is directed towards a method of recognizing an image of a nozzle hole. The method includes picturing a nozzle hole of a liquid droplet ejection head in a state of being filled with a function liquid to thereby perform image recognition thereof. The nozzle hole is pictured synchronously with the application of a driving waveform to the liquid droplet ejection head. The driving waveform causes single-period micromotion of a meniscus surface of the nozzle hole. Advantageously, the picturing is only performed at a timing in which the meniscus surface is pulled into an inside of the nozzle hole due to the driving waveform.

Amended claim 5 is directed towards a method of inspecting a nozzle hole. The method includes picturing a nozzle hole of a liquid droplet ejection head in a state of being filled with a function liquid to thereby check for the presence or absence of foreign matter adhered thereto. Advantageously, the nozzle hole is only pictured at a time

when a driving waveform is applied to the liquid droplet ejection head and a meniscus surface of the nozzle hole is pulled inside.

Thus, each of amended claims 1 and 5 calls for picturing to only be performed at a time when the meniscus surface of the nozzle hole is pulled into an inside of the nozzle hole. As stated in the specification starting at page 22, the "micro-vibration waveform" causes single-period micromotion of the meniscus surfaces of the nozzle holes 53 without ejecting the function liquid. When the driving waveform is not applied, the meniscus surface is sometimes formed into a slightly convex shape relative to the nozzle surface 42, as shown in FIG. 5A. Once the "micro-vibration waveform" is applied, each meniscus surface starts to be pulled into the inside of the nozzle hole 53 (toward the pressure chamber 61) in the process of P7 shown in FIG. 4B (the same applies to the process of P1). Thereafter, in the subsequent process of P8, as shown in FIG. 6A, the meniscus surface is shifted to a predetermined position and the pulled state is maintained. At the same time, the inner circumference portion of the nozzle 53 on its ejection side is exposed. Thereafter, in the process of P9, the meniscus surface is pushed out to the outside (ejection side) of the nozzle hole 53, and is returned to the original position shown in FIG. 5A.

FIGS. 5A and 5B are explanatory views for explaining an influence of the meniscus surface on the image recognition unit 9 in case where the "micro-vibration waveform" is not applied. When the strobe 71 emits light to the nozzle hole 53 without changing the meniscus surface, irregular irradiation occurs on the meniscus surface as shown in FIG. 5A. As a result, an image of the nozzle hole 53 cannot be captured

appropriately like in the picturing result of the recognition camera 72 shown in FIG. 5B. Thus, complicated image preprocessing becomes necessary.

On the other hand, FIGS. 6A and 6B are explanatory views similar to the above in which the "micro-vibration waveform" is applied. As shown in FIG. 6A, the strobe 71 emits light to the nozzle hole 53 in a state in which the meniscus surface is pulled into the inside of the nozzle hole 53, so that irregular irradiation of the meniscus surface can be avoided. Since the influence of the meniscus surface can thus be eliminated, the recognition camera 72 can appropriately capture an image of the nozzle hole 53 as shown in FIG. 6B, and the image processing by the image processing section 94 becomes simple.

FIG. 7 is a time chart showing an example of timing of application of the "micro-vibration waveform", light emission of the strobe 71, and image capture, in the image recognition method of the nozzle hole 53. As shown in the figure, a strobe driving signal rises with a predetermined time delay from the start of the application of the "micro-vibration waveform" to the piezoelectric element 62 (rise), and the strobe 71 emits light with the timing of the signal. While the strobe 71 is emitting light, an image of the nozzle hole 53 is captured by the recognition camera 72.

In this manner, based on the trigger signal of the "micro-vibration waveform" outputted from the head driver 97, the strobe driver 98 causes the strobe 71 to emit light at the time of pulling the meniscus surface into the inside of the nozzle hole 53 (FIG. 4B: P7), and an image of the nozzle hole 53 is captured by the recognition camera 72 in a state in which the nozzle surface 42 is being pulled as shown by P8 in FIG. 4.

In contrast to the foregoing, Motoshi teaches detecting oscillations of a meniscus surface between a pulled state and a pushed state relative to a nozzle forming plate. See paragraph [0017] of Motoshi. As such, Motoshi teaches detecting changes in the reflective direction of light not only when the meniscus surface is in a pulled state BUT ALSO when the meniscus surface is in a pushed state. This is clearly illustrated in Figure 3. Since Motoshi teaches detecting reflective light when the meniscus surface is in a pushed state, Motoshi would be faced with the exact problems the present invention intends to avoid. That is, irregular irradiation would occur and complicated image preprocessing would be necessary.

It is a longstanding rule that to establish a prima facie case of obviousness of a claimed invention, all of the claim limitations must be taught or suggested by the prior art. *In re Royka*, 180 USPQ 143 (CCPA 1974), see MPEP §2143.03. Furthermore, when evaluating claims for obviousness under 35 U.S.C. §103, all of the limitations must be considered and given weight. *Ex parte Grasselli*, 231 USPQ 393 (Bd. App. 1983), MPEP § 2144.03. Here, the alleged combination fails to disclose picturing only at a time when the meniscus surface of the nozzle hole is pulled into an inside of the nozzle hole.

Inasmuch as the prior art fails to teach or suggest all of the claim limitations, the prior art cannot render claims 1 and 5 unpatentable. Therefore, Applicant respectfully requests reconsideration and withdrawal of this rejection.

Claims 3 and 4 depend from claim 1 and should be in condition for allowance for at least the same reasons as set forth above.

Claim 6 depends from claim 5 and should be in condition for allowance for at least the same reasons as set forth above.

CONCLUSION

It is believed that all of the stated grounds of rejection have been properly traversed, accommodated, or rendered moot. Applicant therefore respectfully requests that the Examiner reconsider and withdraw all presently outstanding rejections. It is believed that a full and complete response has been made to the outstanding Office Action and the present application is in condition for allowance. Thus, prompt and favorable consideration of this amendment is respectfully requested. If the Examiner believes that personal communication will expedite prosecution of this application, the Examiner is invited to telephone the undersigned at (248) 641-1600.

Respectfully submitted,

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